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Export Operations
A Draft Proposal
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The rules which will govern exports, both in the short- and long-term are a critical part of the CALFED solution. However, these rules have received relatively little discussion as yet.

I. CRITERIA FOR WORKABLE OPERATIONS

The set of export rules ultimately chosen should ideally be able to meet a number of criteria:

- Protective. The rules should be intrinsically protective of the environment (even without real time management).
- Predictable. For given hydrological conditions and infrastructure, water exporters should have assured access to a given amount of water *and no more. That is, exports should be subject to a flexible cap which rises in wet years and falls in dry years.* Given existing infrastructure, that cap should be set at levels which are approximately equal to current exports. Regulatory restrictions which drive exports below these assured levels must be compensated for. Predictability also includes the need to be able to predict deliveries during the upcoming summer with some accuracy.
- Compatible with real-time management by DERA. The rules should allow for the flexibility to adjust exports according to real-time biological conditions without reducing export supplies.
- Compatible with market transfers. The rules should allow for predictable market transfer of water across the Delta above any cap, and should not require water taxes significantly greater than the damage caused by the transfer.
- Promote cooperation between the environmental manager and the export projects. The project operators and DERA should each have behavioral incentives to act in ways that promote the interests of the other side.
- Share the benefits of future changes. Include rules for a sharing of benefits between the environment and the projects for future infrastructure improvements.

II. TRADITIONAL APPROACH: DAILY LIMITS BASED UPON DATE AND HYDROLOGY

The traditional approach to controlling exports violates all of these criteria to a greater or lesser degree.

We have traditionally created a daily export limit based upon the time of year and the hydrology of the year. Thus, wet years have different export standards from dry years and exports are more constrained in the spring than in the fall. The D 1480 export standards were of this type, as are the E/I ratio standards contained in the 1995 WQCP.

Historically, this approach has been problematic for the environment because the export standards allow much more pumping over the course of a year than actually takes place. The reason this occurs is that there are an infinite number of possible hydrological sequences. The development of standards which are protective, but not unduly constraining on the projects is difficult. Unless standards are very sophisticated, they will either put the environment at risk or put the users at risk in various years. Historically, the approach of the SWRCB has been to set standards which would allow for exports far above actual exports in most years and to rely for environmental protection upon the inability of the projects to operate up to the standards.

The gap between actual exports and allowable exports is a caused by a lack of export demand, or enough upstream or downstream storage, or the pumping capacity to take advantage of all the pumping opportunities allowed under the standards. This gap causes a tremendous amount of conflict in various guises.

1. Discretion. To the extent that demand is below what current infrastructure (pumping capacity, canal capacity, storage capacity) and standards would allow for, the projects have discretion in how they operate their systems.[1] If they choose, they may select a pumping pattern that is fish friendly or fish unfriendly, particularly w/r to unlisted species. In general, the projects would prefer to pump at the highest levels possible (whether limited by standards or capacity) until south of Delta storage is at capacity. Thereafter, pumping would drop to whatever is necessary to meet demand while keeping storage full. This mode of operation reduces the risk of shortfalls (though it might have some negative impacts on water quality).

   By contrast, if environmental managers were operating the projects (but were required to meet export contracts), they would tend to reduce pumping during sensitive periods and low flow periods to protect fish and would maximize pumping during low impact periods and high flow periods. Such a strategy would better protect fish and might improve export water quality somewhat, but would impose increased risk of shortages on exporters. We have already moved some distance in this direction, with ESA take limitations for Delta smelt and winter run salmon, use of the b(2) account to reduce April-May exports, and the opportunity for flexible operations administered by the Operations Group.

   Ultimately, however, we cannot have it both ways with the current infrastructure if we are just talking about water. Either we allow frequently unnecessary damage to the environment to reduce exporter risk or we place greater risk of shortage on exporters. This is the fundamental flaw in the operational flexibility granted to the operations group. Under the Accord and water rights decision 95-6, the Operations Group has the right to grant variances to export standards in order to compensate the projects for reductions in pumping made to protect fish. Ironically, there is a strong imperative for the Ops Group to find makeup water for reductions due to involuntary reductions under the ESA,

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[1] In practice, the SWP exercises far and away the most discretion because it has high pumping and canal capacity in relation to demands.

whereas there is a much weaker responsibility to find makeup water for pumping reductions made voluntarily. This logic is backwards. In order to induce the projects to make voluntary reductions in pumping, the commitment to payback must be stronger, not weaker. Thus, in general, the only export reductions made to help fish have been made (1) under the ESA, (2) using b (2) water -- in which cases we have seen strong resistance from exporters for this imposition of increased risk or water loss -- or (3) under conditions when payback was virtually certain. The flexibility provisions of the Operations Group is not, at present, an adequate tool to allow for consensus based real-time management.

The solution is to compensate interests for their risks. If the environment wishes to impose increased risk on exporters to protect fish, exporters should be compensated either through increased average supplies, with money, or some other means. Similarly, if water users wish to reduce their risks, the environment should be compensated via lower average exports, money, or some other means. Ways to accomplish this are discussed below.

2. Water Development. To the extent that the projects could export more water under the existing standards through increased demand, pumping and canal capacity, storage, or market transfers we have created an additional source of conflict. Increased diversion means more entrainment, whatever the infrastructure and that cannot be good for the environment. Improved infrastructure could benefit exporters because they could take advantage of the current lax standards to pull more water out of the Delta. On the other hand, the infrastructure represents an opportunity to tighten standards without impacting overall water supplies and therefore also represents an environmental opportunity. For this reason whenever new infrastructure is proposed by exporters, a mad scramble to capture as most of the benefits while paying a minimum of the costs ensues. In practice, the result has been a stalemate and no infrastructure has been built.

   If the benefits of improved export infrastructure could be shared between exporters and the environment, then this new infrastructure (e.g., south Delta facilities, south of Delta storage) might be supported by both sides. This could be done either through (1) a tightening of export standards such that exports increased, but net environmental conditions improved or (2) by granting the partial ownership of the new capacity to the environment. This kind of accommodation is possible with current approaches, but only through the clumsy expedient of a new set of export standards every time there is a change to export infrastructure.

3. Transfers. A problem with the existing standards (E/I ratios) are their impact on water transfers. In circumstances where the E/I ratio is less than the standard, transferors have asserted that they have the right to move water across the Delta without any environmental taxes whatsoever, until the E/I ratio is reached. This is patently unfair the environment, as it will have to suffer incremental entrainment impacts without any compensation. On the other side of the coin, after the export ratio is reached, future exports must pay substantial environmental taxes. From July - January, the taxes are 35%

of water released (or over 50% of the water actually delivered) while from February -- June, the taxes are 65% of water released (or almost 200% of water actually delivered). Thus, with the current system, either the environment is shortchanged or water users are charged water taxes large enough to represent a major drag on the market.

In conclusion, the current set of operational controls violates all four criteria set forth at the beginning:

- Standards are not intrinsically protective. Because of operator discretion, the projects may be operated in a fish-friendly, or fish-unfriendly manner at the discretion of the operators.
- Benefits are unpredictable. The "no net loss" provisions of the Accord help increase export predictability, but these provisions are only for new listings, not existing listings. The lack of assured payback for existing take limits and for voluntary pumping reductions makes export levels relatively unpredictable.
- Real-time management is the exception, not the rule. (Discussed above). Where agencies have the authority to force real time management (ESA, possibly b(2) water could be used in this way), it can happen. It rarely happens without compulsion if there are risks involved.
- Market transfers are controversial. Transfers either require no environmental mitigation in the Delta, or very high levels of mitigation. This is not a stable foundation for a market regime.
- The interests of environmental managers and the export projects a misaligned. The project and eco managers have incentives to attack each other's benefits. The environment gains by seeking pumping reductions without a commitment to payback. Export users gain by pumping at maximum allowed rates until demand is met and storage is full, whatever the biological impacts.
- There is no mechanism to automatically share the benefits of new infrastructure.

III. POSSIBLE SOLUTIONS

It seems to me that there are two general approaches possible for improving the existing regulatory regime for controlling exports:

1. The first is to grant project operators and the environment a well balanced and well defined set of operational rights. The interaction between the operators and the environment as each side applies its rights should result in a balanced operational regime.
2. The second is to modify the form of the standards under which the projects operate. By creating a feedback between the amount of damage caused by exports and the amount of water that can be exported, the projects will have a strong incentive to operate in ways beneficial to the environment.

These two approaches are explored in the following two sections.

IV. ALLOCATE DIVERSION RIGHTS TO EXPORTERS AND THE ENVIRONMENT

First, let's review the criteria set out at the beginning. The rules must satisfy the following criteria:

- Protective.
- Predictable.
- Compatible with real-time management by DERA.
- Compatible with market transfers.
- Promote cooperation between the environmental manager and the export projects.
- Share the benefits of future changes.

A rough outline of how to create a rights-based set of rules follows:

1. Each day of the year, calculate how high exports can be that day. The calculation would be based upon (1) seasonal factors (February - June exports are more damaging than August exports); (2) near-real time physical factors (e.g., what was Delta outflow over the past week); and (3) infrastructure factors (e.g., canal and pumping capacities). Thus, for the same Delta outflow, allowable exports would be lower in June than in August. Within June, allowable exports would be higher when Delta outflow is higher. This step is not very different from the way exports are currently configured, except that allowable exports are based upon inflow currently. I believe that it is more appropriate to base exports upon new outflow. The total allowable exports (project rights plus DERA rights) would probably be institutionalized via a new set of SWRCB standards.
2. The projects get the right to pump a certain fraction of allowable exports each day and DERA gets the rights to the rest.
3. As a default, the projects will exercise their rights to pump and DERA will exercise its right by not allowing its portion of the exportable water to be pumped.
4. The pumping rights accorded the projects will be set such that, over the course of the year, the projects will be allowed to pump approximately as much water as they currently export. This represents an export cap which will vary according to the hydrology of the year.
5. Allow the projects and DERA to exchange their rights according to preset rules. For example, DERA might allow the projects to use part or all of its pumping rights on any given day. In return, DERA would receive credits which could be used in the future to reduce project exports. The rules by which DERA and the projects would interact are tricky. On the one hand, we want DERA to be able to reduce pumping when take is high without much debate. This argues for some right on the part of DERA to apply credits against pumping without the consent of the projects. On the other hand, this system will work best when the projects and DERA see mutual advantage in working together. Thus, a blend of the voluntary and the mandatory is probably called for.
6. DERA would be obligated to use its rights to compensate the projects for any reductions in export pumping caused by regulatory reductions beyond the export standards.

As an example, consider the following chart. These dates are simply chosen for convenience. In reality, the chart would have to include each day of the year.

Date	Delta Outflow (cfs)	Project Pumping Rights	DERA Pumping Rights	Actual Pumping	Daily Credits (DERA)	Accumulated Credits (DERA)
June 1	10,000	2,000	1,000	2,500	500	500
July 1	10,000	3,000	1,500	3,500	500	1,000
August 1	5,000	2,000	800	2,000	0	1,000
Nov 1	5,000	1,500	750	500	-1000	0

In the example, note that allowable pumping is higher on July 1 than June for the same level of Delta outflow. Similarly, allowable pumping is lower on November 1 than on August 1 for the same Delta outflow. In August, the distribution of total allowable exports between the projects and DERA is changed to reflect a reduced need for real-time management during this period. On June 1 and July 1, DERA allows the projects to pump 500 cfs from its pumping rights. In exchange DERA gains 2,000 acre-feet of credits (or 1,000 cfs over a day) against the Projects. It then asserts these credits on November 1 when it believes that spring run salmon are in danger of entrainment. The projects get the correct amount of exports and the environment gains from the use of real time management.

This then is the general outline. However, a number of additional issues remain if this approach is to be made workable:

- The Form of the Daily Allowable Export Standard. Benefits for water transfers.

We want an export standard that simultaneously provides enough exports over the course of the year, protects fish, and promotes water transfers. I have considered a number of mathematical possibilities. My current favorite would be a daily export/outflow standard based upon the logistic equation. I will reserve the mathematical treatment for an appendix when I have more time. The bottom line is that allowable exports would be very low when outflow is low. As Delta outflow increases, allowable exports would increase slowly until some breakpoint is reached (e.g., when flow is high enough to push X2 out to some safe distance). Once Delta outflow is higher than the breakpoint, most additional Delta inflows would be subject to export. The breakpoint would be different at different times of the year, depending on the need separate low salinity habitat from the pumps.

I prefer the use of outflow, rather than inflow as the key hydrological variable, because Delta outflow correlates to fish protection and part of the reason is insulation from the pumps. Delta inflow is relatively meaningless, given that diversions into Delta islands are not included in the ratio at present. In any case, my proposed export standard is not all that different from the existing E/I ratio. It is just that with the existing standard, allowable exports are always

proportional to inflow. With my formulation, allowable exports would be derived from a more complicated equation.

A key benefit of using a non linear relationship between flows and exports is the impact upon water transfers. Since water transfers represent Delta inflows above preexisting inflows, they will be subject to the lowest environmental taxes available. In general, this should dramatically lower the water taxes paid by transfers.

- How to allocate the Daily Allowable Exports between the Projects and the Environment.

The simplest approach would be to give the two sides a constant fraction of allowable exports. But this will cause problems. When flows are high, DERA will not have much need to reduce exports so there is no reason to give it much in the way of pumping rights. The guiding criterion should be the degree to which DERA may have need to seek export reductions in real time. This need will be greatest during (1) certain times of the year (e.g., the spring) and (2) during lower flow periods. Thus, a large fraction of the allowable exports might be allocated to DERA during low outflow periods in the spring and only a small fraction allocated to it during high flow periods in July.

- How to Deal with Future Changes in Infrastructure

It should be relatively straightforward to make the rules self-adjusting, provided that the intakes remain in the south Delta. The rules should accommodate the following changes without changing the basic SWRCB standards:

- South Delta facilities.
- Joint Point of diversion
- South of Delta storage
- North of Delta storage

In addition, we will need to agree on how the rules will be modified should an isolated system be constructed.

The basic idea is that the benefits of improvements in infrastructure or flexibility should be shared between water users and the environment. Joint point of diversion should not be a problem. In effect, this proposal assumes that joint of diversion has already been granted and that the state and federal projects can agree on how to divide up the daily allowable exports.

North of Delta storage facilities should be easy to deal with. The facilities will shift Delta inflows from periods of high flow (when the pumps are maxed out) to periods of low flow (when additional physical capacity exists). Increased Delta inflow automatically leads to an increase in the Daily Allowable Export (as well as increased Delta outflow). Therefore, water development north of the Delta is automatically incorporated into the standard. How to make upstream water development compatible with a cap is a problem for another forum.

South of Delta infrastructure is problematic. I will try to have a solution for the next iteration.

- Other issues I haven't worked out in much detail yet.

  - To what extent could DERA borrow against future credits to force a reduction in exports. This is the problem faced by the Operations Group. It is frequently called upon to reduce export pumping with the expectation that the projects can make up the loss later. This gap causes resistance by exporters who are at risk that debts will not be paid.
  - The projects occasionally go off line to perform maintenance or repairs. Under this approach, how would be they be allowed to make up for lost pumping?
  - The projects would be able to increase total exports with the current system by manipulating Delta inflow patterns. These changed patterns may cause unintended environmental harm. How can this harm be minimized? How can benefits be shared?
  - There should be a way to carry over limited numbers of credits from year to year. This would reduce the distortions caused by the need to have the numbers exactly balance each year. For example, if DERA had some credits against the projects going into the summer, it might shut down the projects with no biological justification in order not to lose its credits. Better to carry them over into the next year and use them when they can help the fish.
  - This scheme makes no explicit allowance for operations based upon water quality parameters. As long as the pumps are in the south Delta, this problem is probably manageable. Higher water quality tends to occur during times when pumping is less impacting (i.e., high flow periods) so that operations to protect fish should also protect water quality. The projects retain the right to trade pumping rights with DERA to improve water quality still further.
  - However, how would this export regime change with the addition of an isolated system, while retaining the south Delta pumping location? Now both the projects and DERA become concerned about, not just how much water is being pumped, but where it is being pumped from. Fishery protection, export volume, and export water quality are no longer necessarily mutually reinforcing. If DERA seeks to shut the isolated system due to localized fishery problems, it may not be causing a reduction in export quantity, but rather in export quality.

V. EXPORT RULES BASED UPON ENTRAINMENT CREDITS

What the environment cares about is the amount of damage caused by the export pumps, perhaps on an annual basis. If we could define in a rough sense the damage caused by diversions, we could set an annual cumulative total as the standard. We could do this with or without including real-time biological operations. Because of the quirky nature of real-time fish density patterns, I think that the real-time piece of this is best dealt in a market or bartering system, not within the standards.

Ignoring real-time bio data, the damage at any given time would depend upon, among other things:

- o Time of year
- o Real-time Delta outflows
- o Level of pumping by export pumps
- o Quality of screens at export pumps
- o Level of Delta island pumping
- o Quality of screening of Delta islands
- o Tributary inflows (e.g., San Joaquin flows in April and May)
- o Past flow patterns (big pumping might be more harmful in the second or third year of a drought)

The function might look like this, for any given day:

$$E_d = \alpha_d \frac{exports}{\gamma_d outflow + \beta_d SJRflows}$$

where

E	=	Entrainment credit
d	=	Denotes the day of the year
exports	=	Total state and federal exports on day "d".
SJR flows	=	San Joaquin flows at Vernalis on day "d".
outflow	=	Delta outflow on day "d".
α	=	Export weighting factor. α would be high from February through June, lower from November through January, and very low from July to August.
β	=	San Joaquin weighting factor. β would be relatively high during the San Joaquin spawning periods -- March through May and October -- and would be very low (or zero) during other times).
γ	=	Weighting factor for Delta outflow. To do this properly, should probably be outflow minus SJRflows, but that is a refinement.

The actual standard that the state and federal projects would be subject to would be that:

$$\sum_{d=1}^{365} D_d \leq Annual\ Damage\ Allowance\ (ADA)$$

α, β and ADA would be chosen to allow for approximately current levels of exports, assuming that operators will act to maximize exports. If we believe that operational shifts resulting from this standard will provide environmental benefits, we might adjust the numbers to allow for a modest increase in average exports. This is something that export ag, in particular, has pushed for.

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Note how this differs from current export restrictions. The current standard sets daily maxima for exports based upon either the ratio of exports/inflow or exports/SJRFlow. Export shortfalls during any day cannot be made up later. The operators have no incentive to pump less than the allowed standard on any given day because there is no feedback between the damage done the environment and the amount of water exported.

By contrast, this system would give operators an incentive to operate their projects in an environmentally sensitive fashion. They could pump a lot of water during harmful times. However, to do so would be to accumulate damage debits quickly. Alternatively, they could wait until conditions are favorable and then move water at a high rate. In this way, the interests of the exporters (to maximize exports) are aligned with the interests of the environment. Another way of saying this is that the environmental costs of pumping are internalized into decision making by the operators. We have not constrained operator flexibility. In some ways, we have increased it by freeing the operators from strict daily standards. This is not much different from an air quality board setting limits on basin discharges of pollutants -- they are regulating how much harm an industry can impose upon a resource (air). How the industry complies is up to them. In some ways, this is also similar to the cumulative take limits for winter run salmon, except that this standard is based entirely upon physical (hydrological) factors.

Moreover, this approach would allow for an easier resolution of facilities issues. Operators would have an incentive to invest in facilities in order to export additional water without violating the damage cap. For example, the proposed south Delta facilities would allow for greater exports during periods when the damage function is low (high winter flow periods) and would be very attractive to water users. But at the same time, enviros should be less concerned about the facilities. Because water users must still live within the same annual damage cap, they will have strong incentives to use the new facilities to shift pumping out of sensitive periods. Similarly, north and south of Delta storage could also become more attractive both for water users and the enviros.

I don't think that we could stick with the same function if we constructed a new isolated facility, however. In that case, we would need to negotiate a new function and a new cap.

- Other bells and whistles

If we could estimate the relative damage caused by diversions into Delta islands, then we could raise the export cap as damage done by Delta island diversions is reduced. This would give export users an incentive to screen Delta island intakes, or to convert land to habitat. Similarly, we could increase ADA if the new screened intake proposed by CALFED to Clifton Court were built.

We could also allow some limited carryover of credits (positive or negative) from year to year. This would reduce the importance exactly hitting the total allowed damage each year. Instead, in a very dry year, water users might pump less than their allotment because the damage cost per acre-foot is so high. Instead, they would carry over part of their allocation in the hopes that the next year would be wetter and more water could be pumped for the same damage allotment.

Similarly, water users might want to overpump in a very wet year, when the conversion rate is low and store the water for drier years.

NOW ADD REAL-TIME MANAGEMENT

OK. What is still missing is real-time management. The above equations may, in an average way, reflect the damage done by exports. However, real-time fluctuations might cause significant variations in damage. What BJ originally suggested is basically to include damage functions for fish take so that exports can rise when take is low (compared to some reference point such as a population index) and fall when take is high. My concern with this approach is that it puts no effective limit on exports, but allows them to increase without limit as long as populations of fish increase in the future. Enviros will not buy that. BJ has more recently adjusted his proposal to include an annual export cap, tuned to the hydrology, with some variation which might depend upon real-time factors. I am proposing something similar, though as described above, my cap would not be in units of acre-feet but in units of "damage" with a rights based approach to real-time management.

Rather than try to incorporate fish take into the damage equation above, I would propose to give DERA specific rights to influence export pumping on a real time basis. For example, DERA might have the following property rights:

- The right to shut down exports entirely. E.g., 10 days per year.
- The right to increase and decrease α_d by up to 20% up or down, provided that the total percentage deviation in α_d is zero over the year. For example, if fish take seems high, DERA might increase α_d by 20% over a given week. In order to compensate the water users, DERA would need to find another week when α_d would be lowered by 20%. This needs more work. My thinking is that the formula for deviations should be set so that the use of deviations will generally provide a modest increase in overall exports. In this way, the water users will feel comfortable supporting the deviations and both sides can share in the benefits of flexibility. However, control of the deviations will be in environmental, not operator control. Note, however, that this is not designed as "no net loss" on a gallon per gallon basis. The accounting for "no net loss" has proven to be too contentious (requiring as it does, the calculation of how much pumping would have occurred in the absence of pumping deviations).

ENVIRONMENTAL MARKET ELEMENTS

What I have described so far should work fairly well without any additional elements. However, I would propose to add a number of market elements to add even more flexibility:

- DERA might hold rights to some amount of annual damage. DERA could use those rights to export its own water, could sell its rights to water users, or could simply not exercise its rights.
- Similarly, DERA should be able to purchase portions of ADA from the state and federal projects. This needs work. Presumably, individual contractors would not be thrilled

about the SWP or USBR selling off some of their diversion rights. But since the standards are based, not upon water but upon diversion impacts, it will be difficult to purchase

- If we allow increases in the annual damage allowance for such actions as screening Delta islands, consolidating diversion points, or improving the state and federal intakes, then I would propose to allow whoever takes those actions to own the new property right in entrainment. This would effectively create a private market in entrainment reduction.
- If we wanted to get very complicated, we could calculate an overall basin wide ADA, including not only export impacts, but also island impacts and upstream diversion impacts. Then, we could apportion ADA rights to individual diverters. Finally, we could allow an ADA market to form. If someone wants to divert more water, they would need to reduce their damage function (e.g., by improving screening) or by purchasing ADA from some other rights holder. However, the monitoring problems and the conversion problems are probably too difficult. Forget I said anything.

TRADITIONAL WATER MARKETS

How would water transfers move in this regulatory atmosphere? I see several possibilities:

[needs to be filled in]